Figure 1a - UV Absorption of Combustion Gases

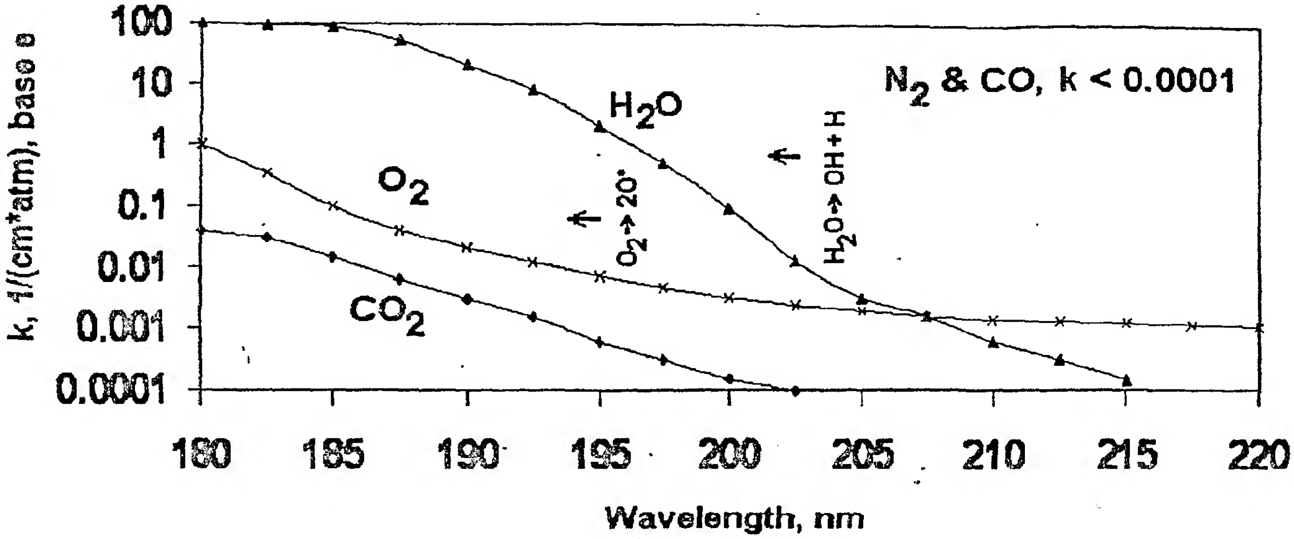


Figure 1b - UV Absorption of Nitrogen Based Gases

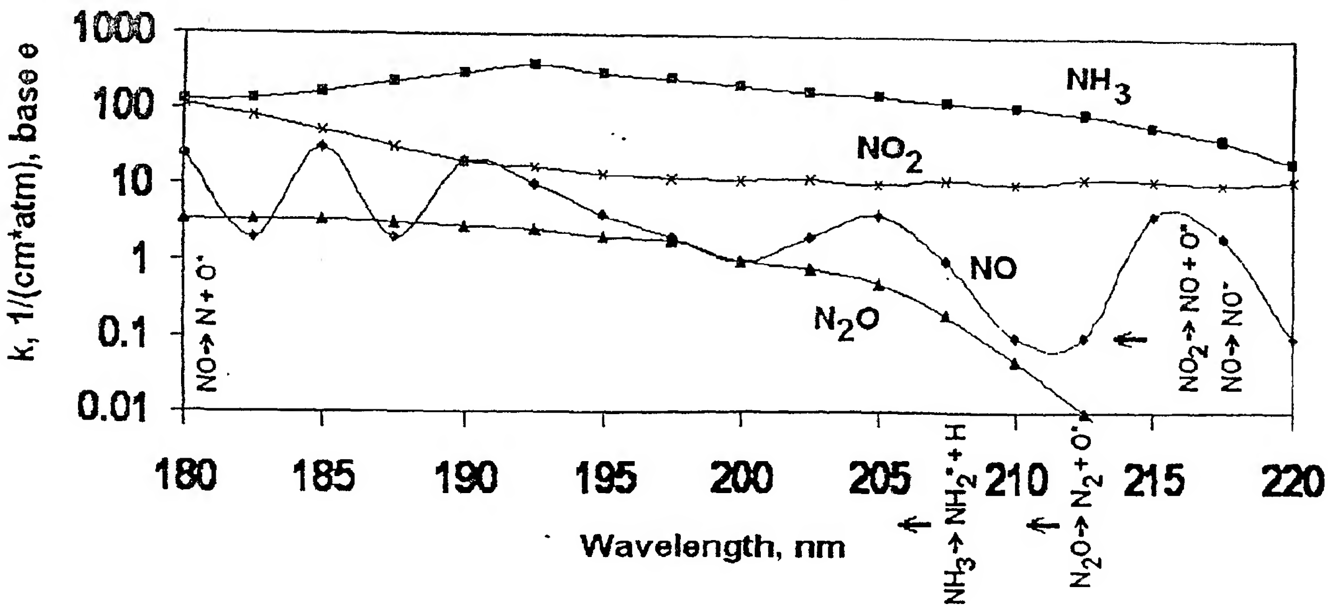


Figure 1c - Important Secondary Reactions

Oxidation

$O' + CO \Rightarrow CO_2$
$O' + NO \Rightarrow NO_2$
$O' + H_2O \Rightarrow 2OH$
$O' + NH_3 \Rightarrow NH_2' + OH$
$OH + CO \Rightarrow CO_2 + H$
$OH + CH_2O \Rightarrow H_2O + HCO$
$OH + NO \Rightarrow H + NO_2$
$OH + NO_2 \Rightarrow HNO_3$
$OH + NH_3 \Rightarrow NH_2' + H_2O$
$HCO + O_2 \Rightarrow HO_2 + CO$
$H + O_2 \Rightarrow HO_2$
$HO_2 + NO \Rightarrow OH + NO_2$
$HO_2 + CO \Rightarrow OH + CO_2$

Reduction

$NH_2' + NO \Rightarrow N_2 + H_2O$
$NH_2' + NO_2 \Rightarrow N_2 + H_2O_2$
$H + N_2O \Rightarrow N_2 + OH$
$H + NO \Rightarrow HNO$
$H + NO_2 \Rightarrow HNO_2$
$H + O_2 \Rightarrow HO_2$
$H + CO \Rightarrow HCO$

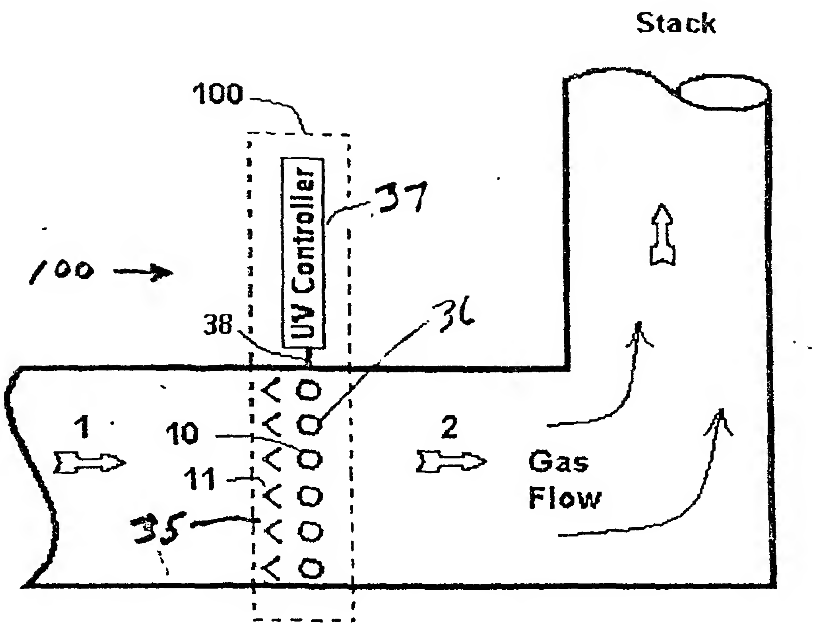


Figure 2a - Use of SUVR to Destroy Combustion Contaminants and/or VOC's

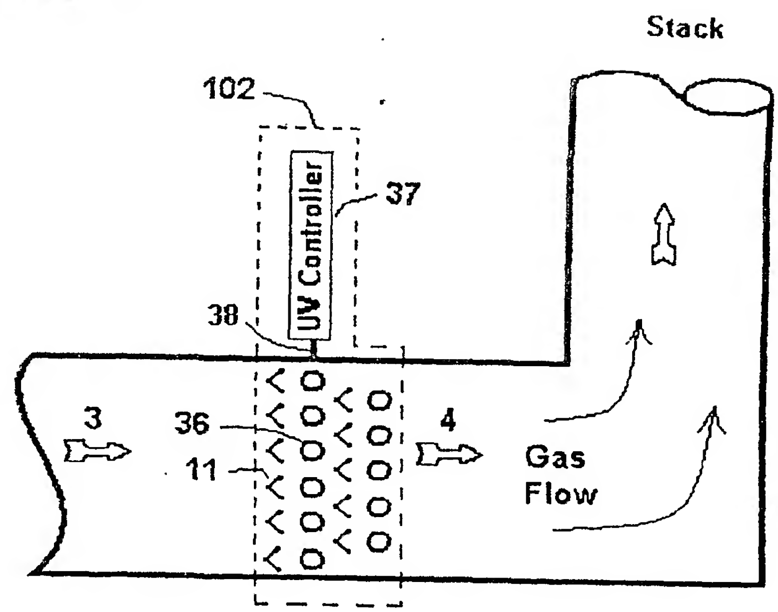


Figure 2b - Use of SUVR to Polish Residual NO_X and NH_3 Gases from an Upstream SNCR, SHR, or SCR Process

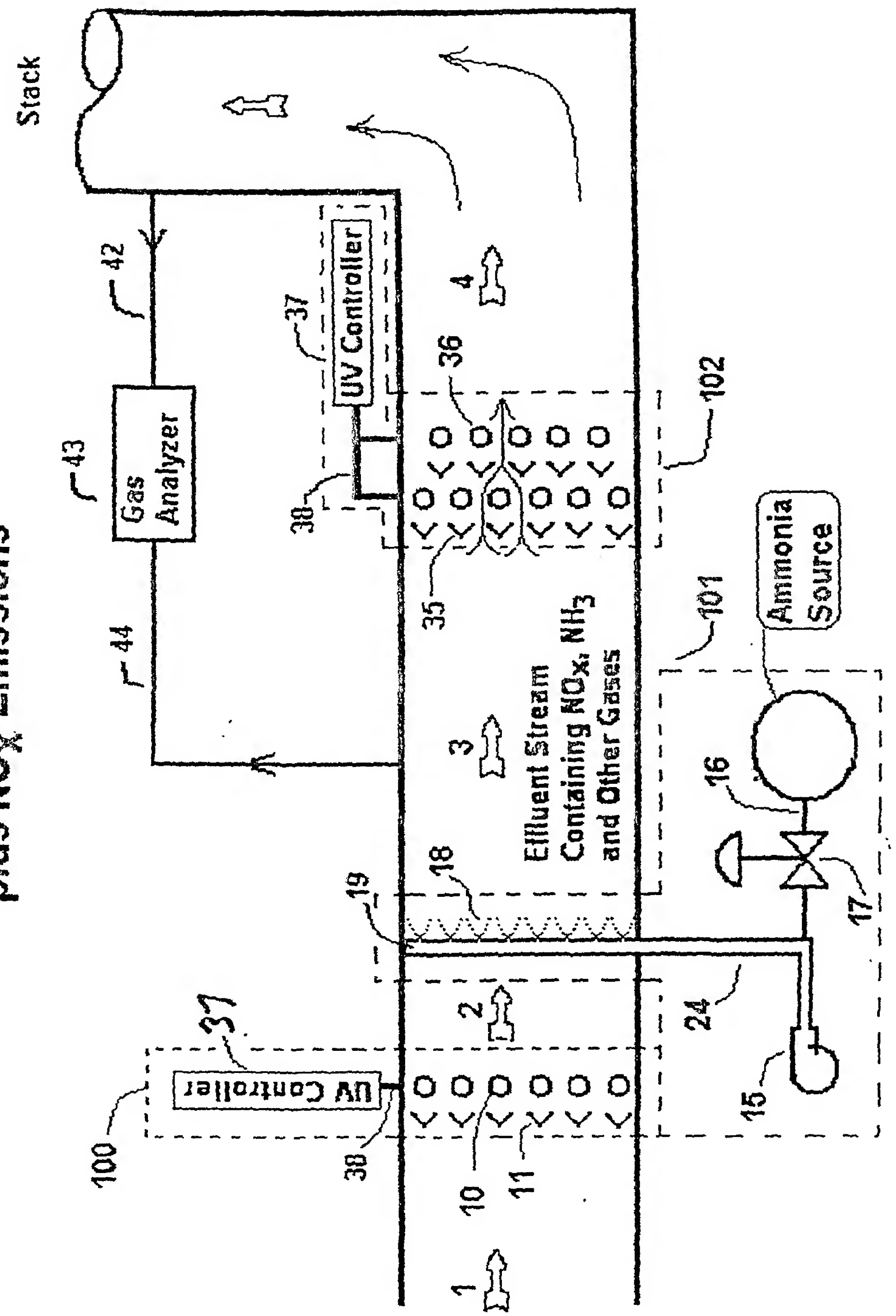
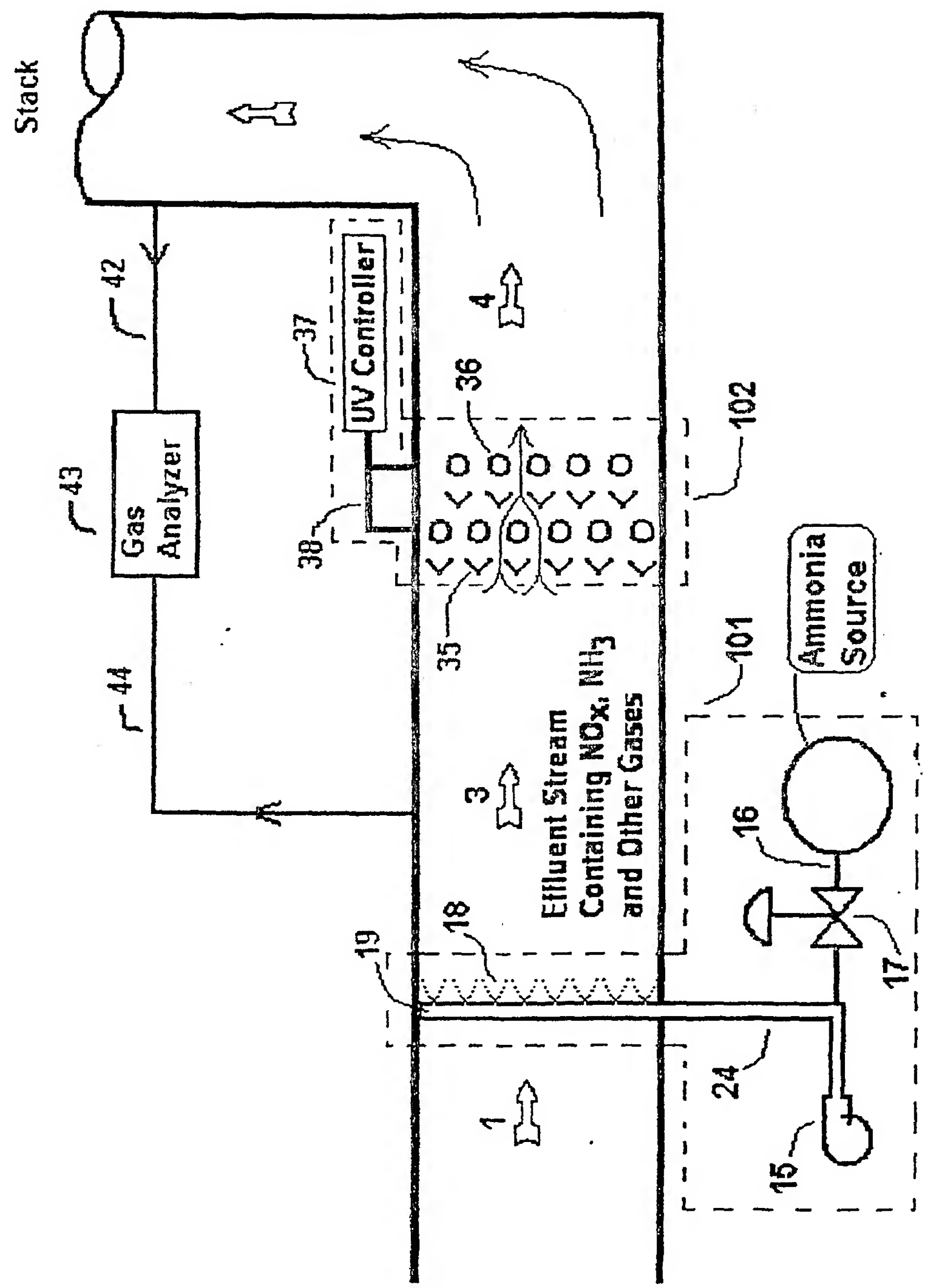


Figure 3a - SUVR to Control Combustion Contaminants and/or VOC's plus NO_x Emissions

Figure 3b - SUVR to Control NO_x Emissions



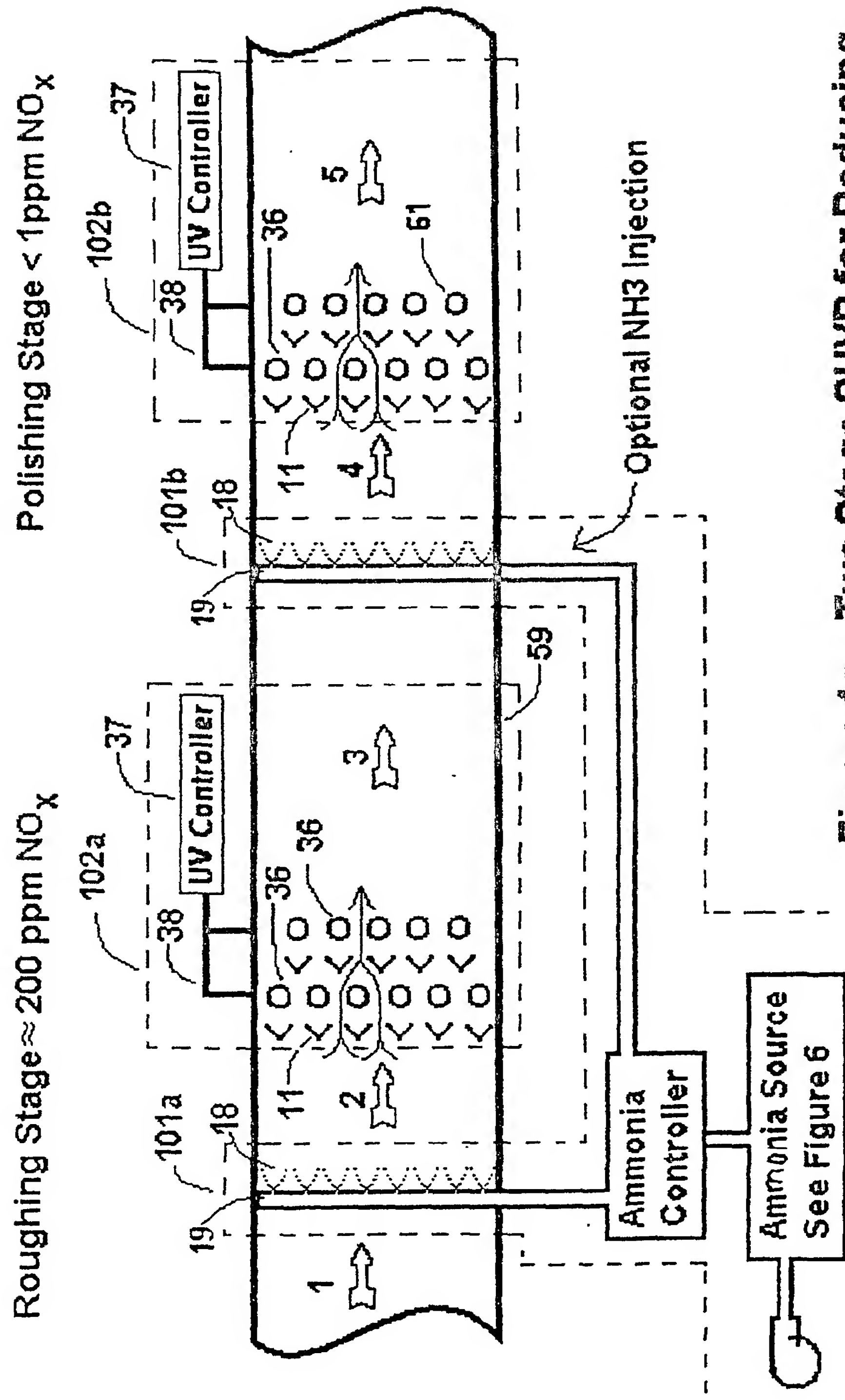


Figure 4a - Two Stage SUVR for Reducing NO_x Emissions

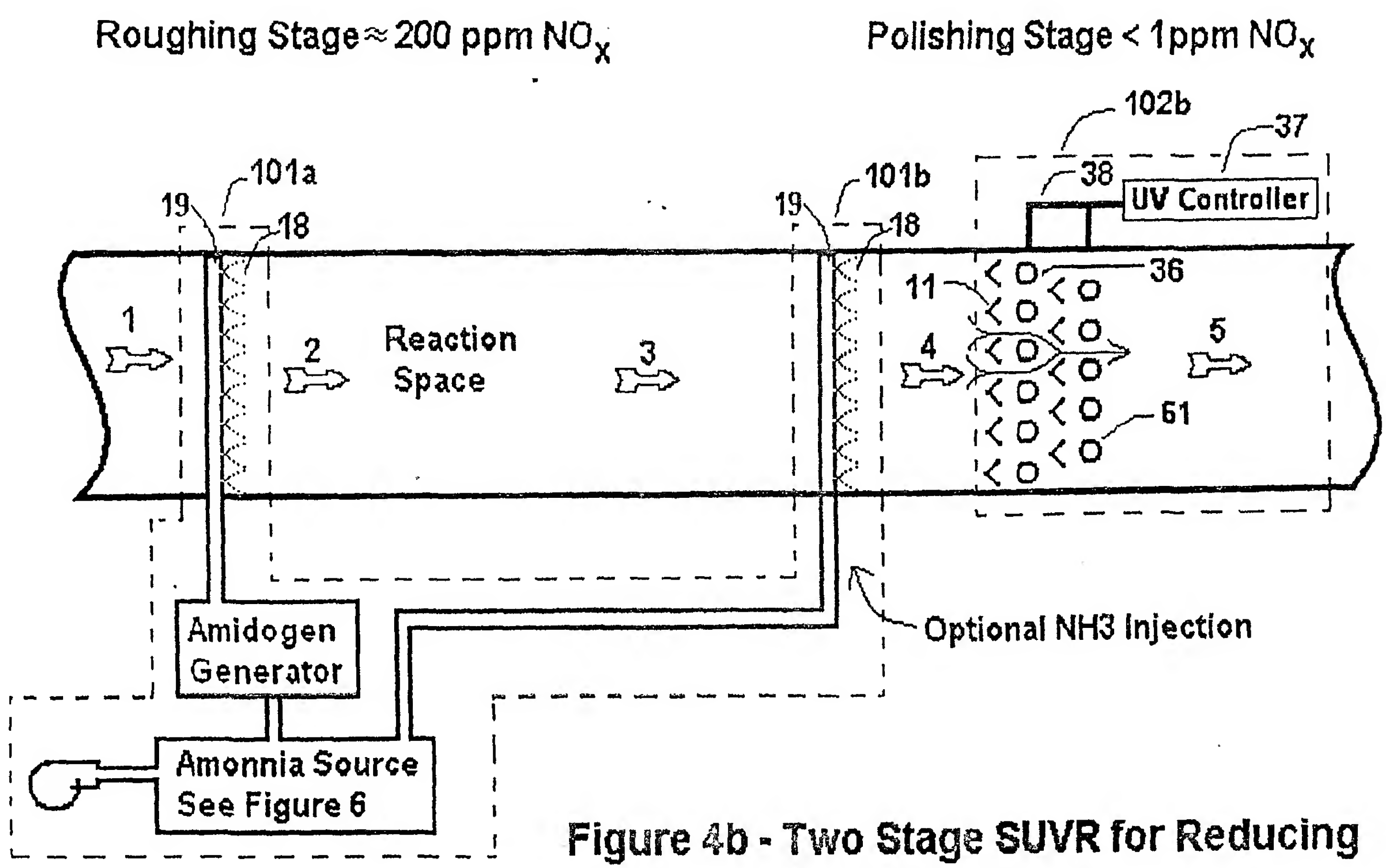


Figure 4b - Two Stage SUVR for Reducing NO_x Emissions

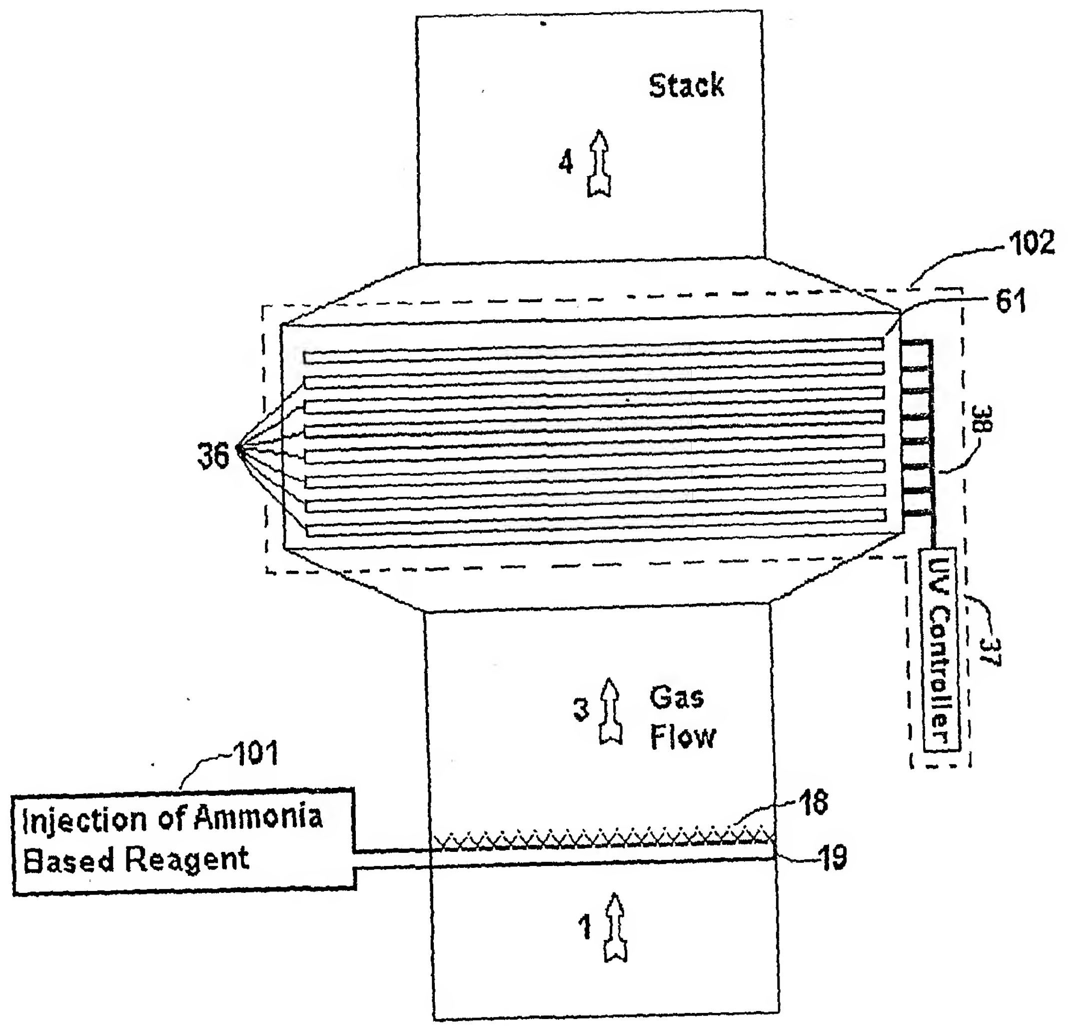
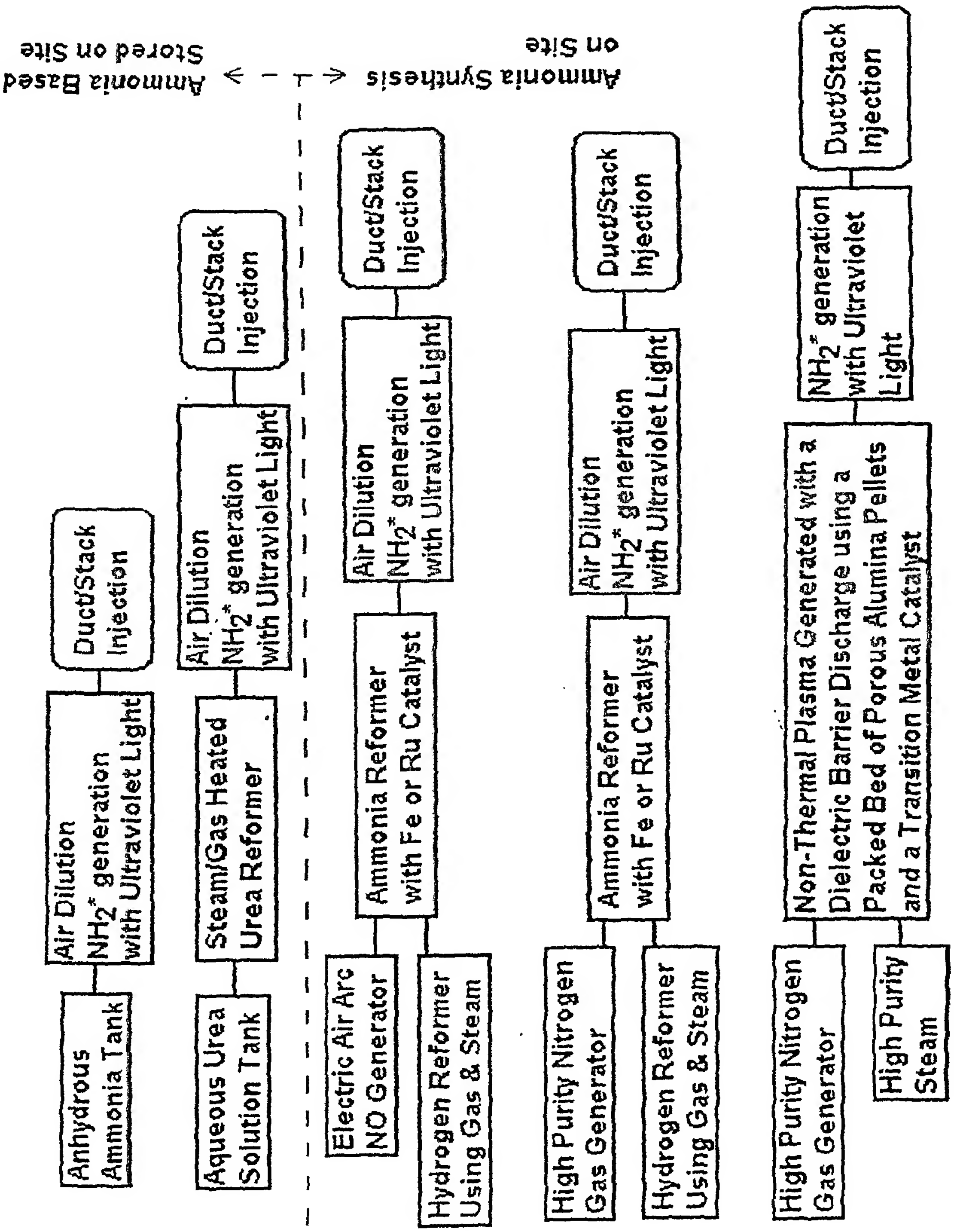


Figure 5 - Installation of the SUVR process on a Combustion Device to Remove NO_X and Residual NH_3 Emissions; Replacing the SCR Process

Figure 6 – Ammonia Sources for Exicited State Amidogen Radical (NH_2^*) Generation



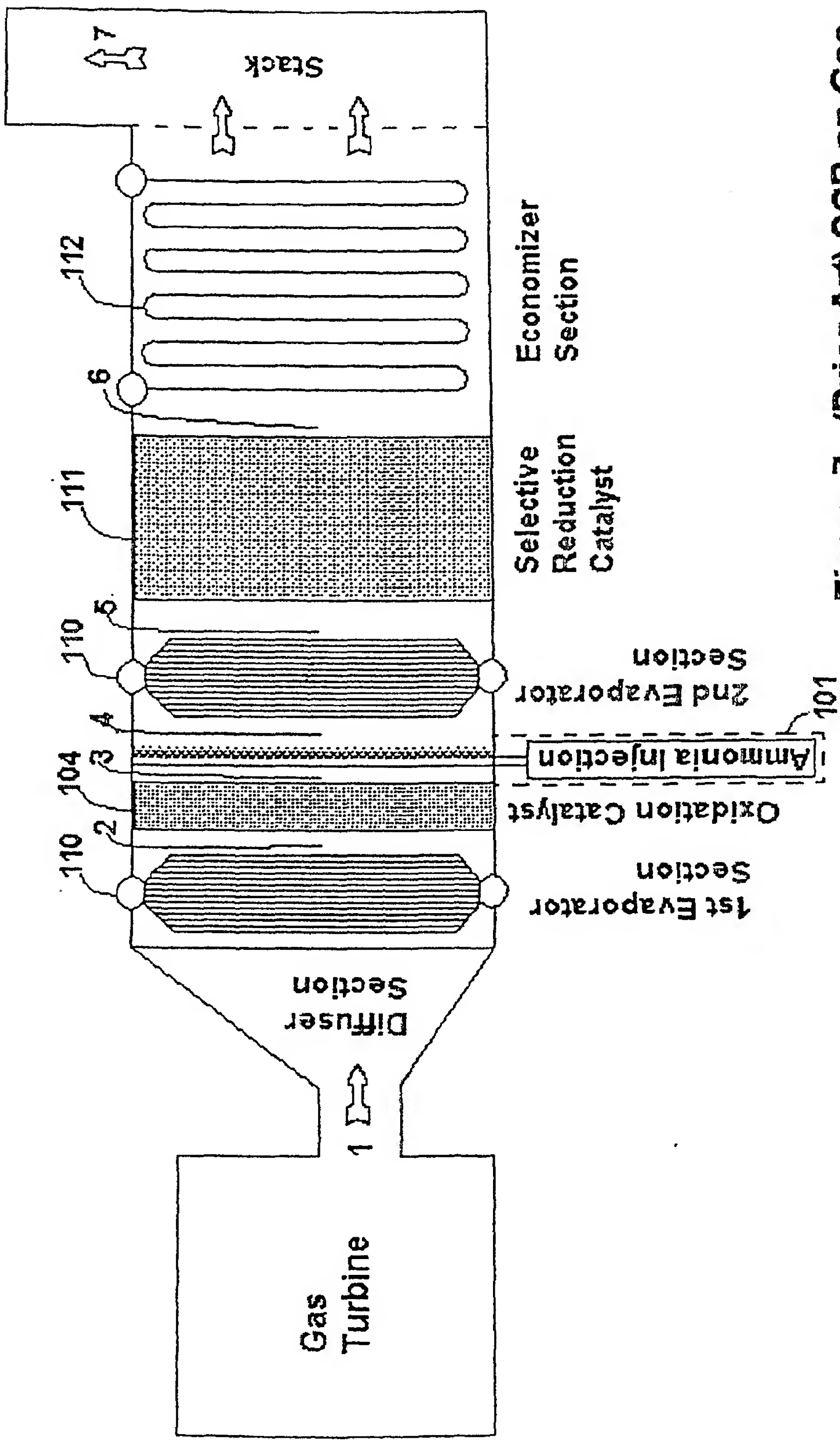


Figure 7 - (Prior Art) SCR on Gas Turbine Waste Heat Recovery Boiler

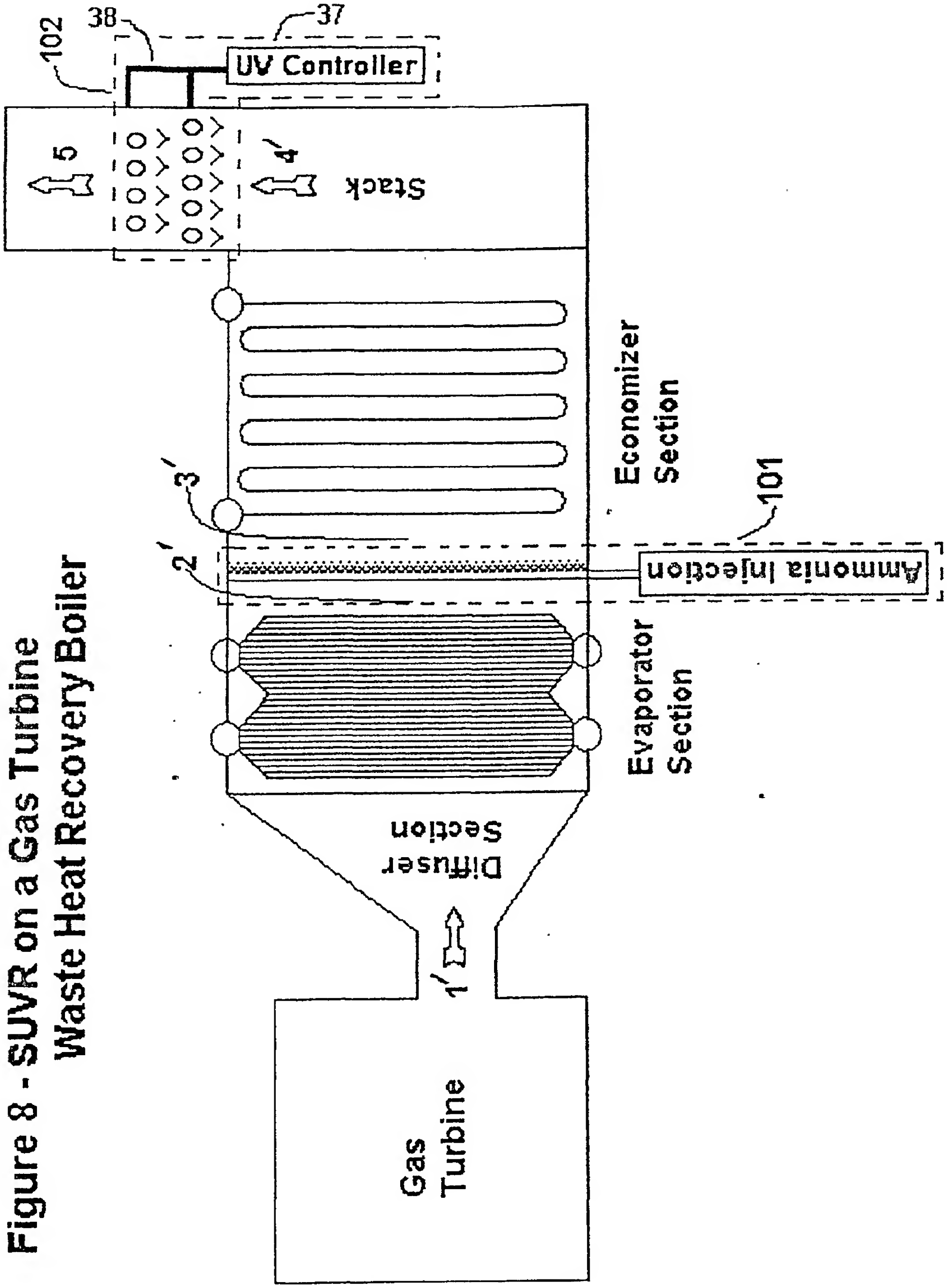


Figure 8 - SUVR on a Gas Turbine Waste Heat Recovery Boiler

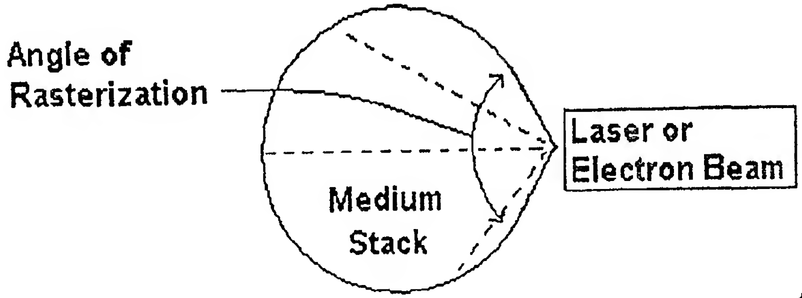


Figure 9b

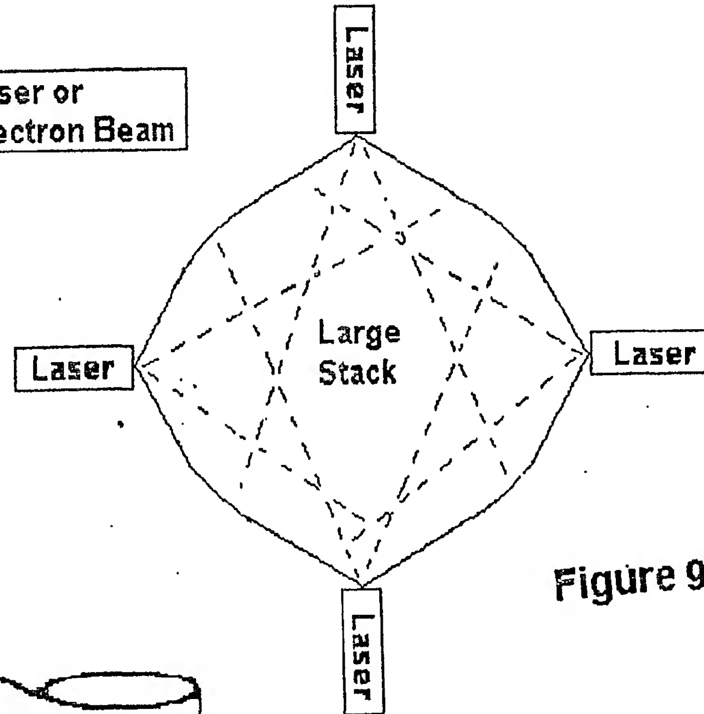


Figure 9a

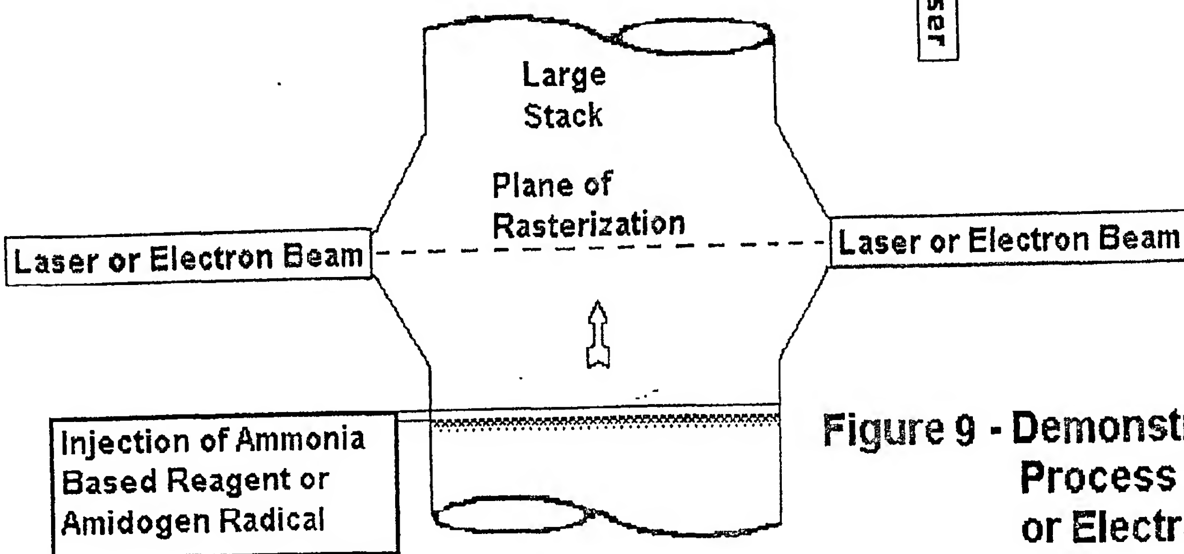


Figure 9 - Demonstration of the SUVR Process using a UV Laser or Electron Beam for Activation

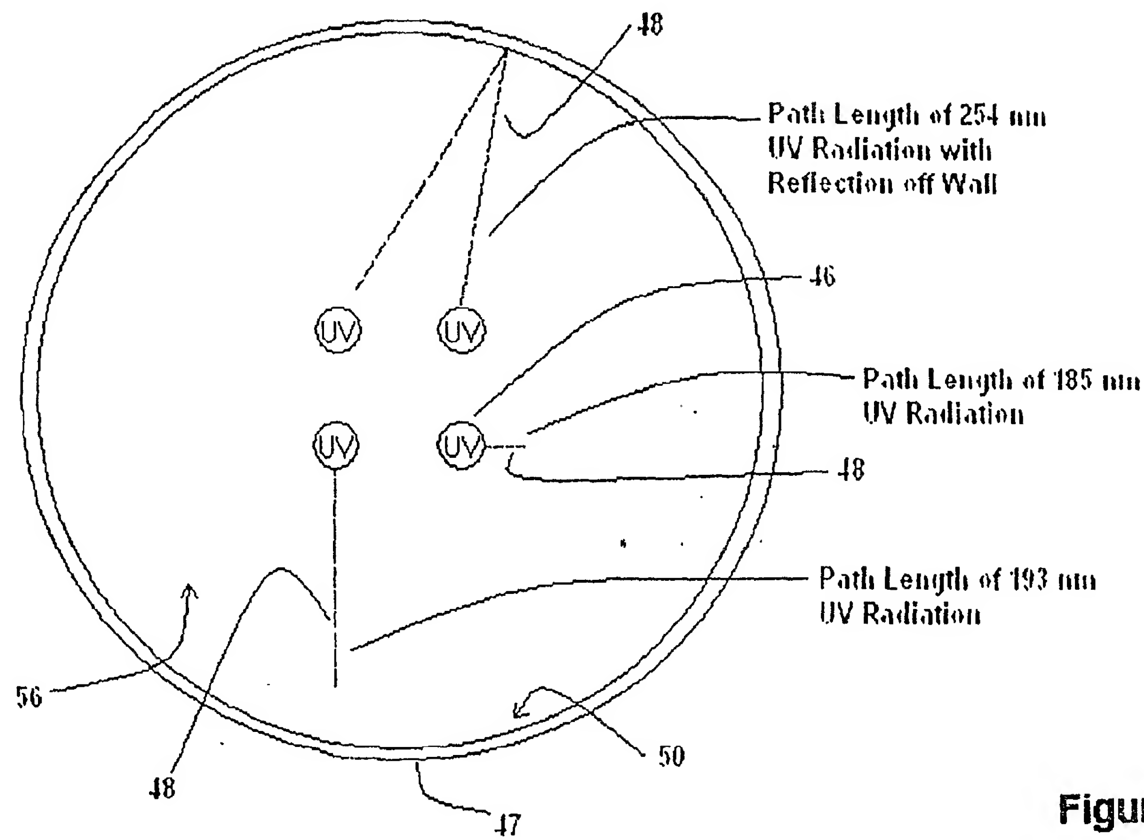
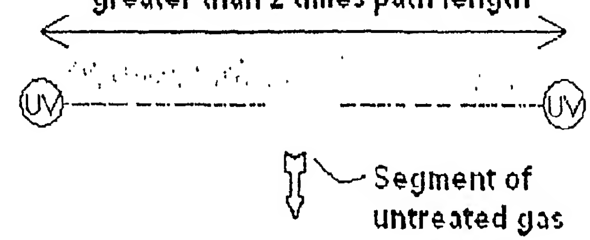


Figure 10 - Relative Transmission Path Lengths of UV lines from a low Pressure Mercury Vapor Lamp

Figure 10a



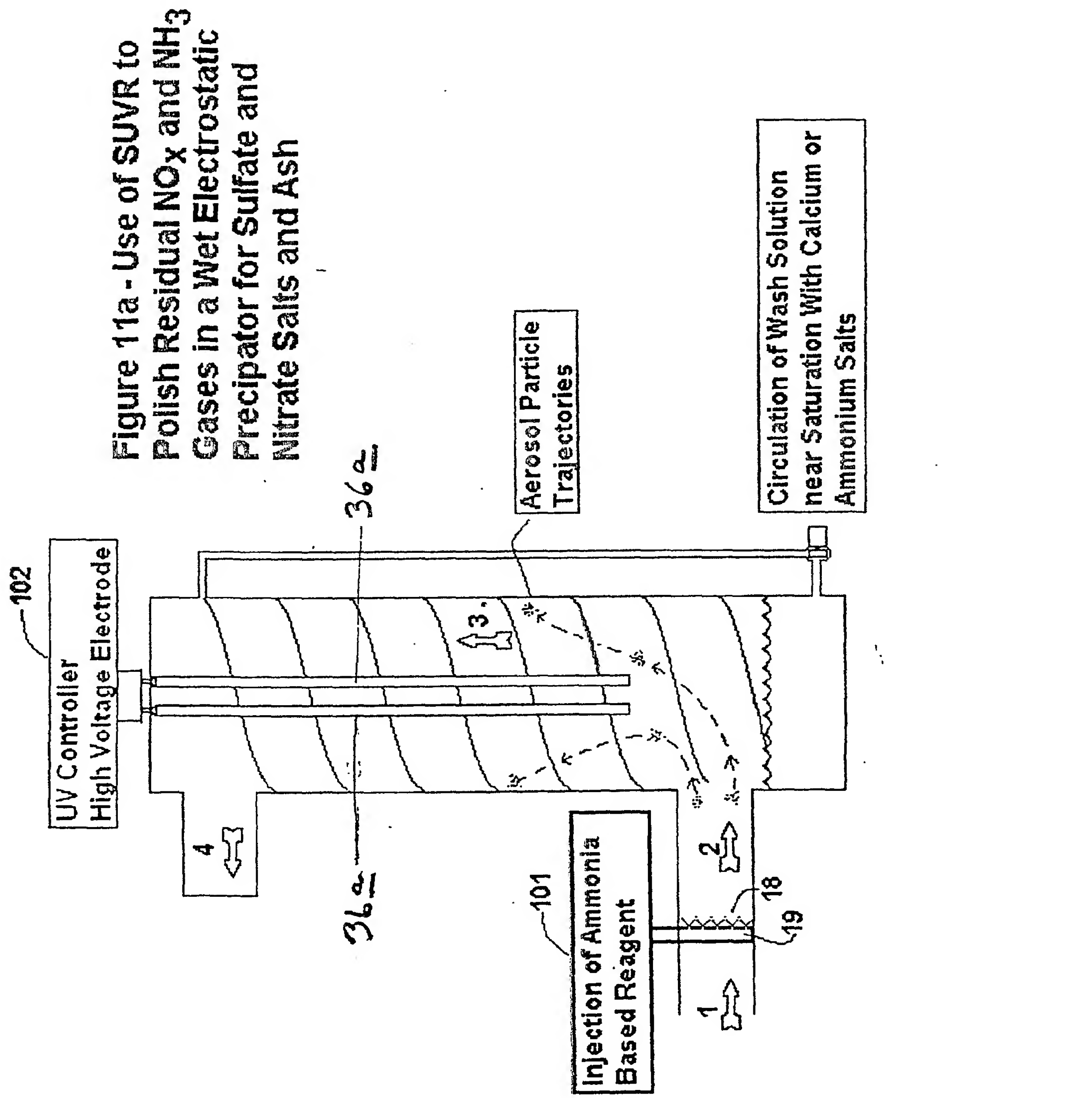


Figure 11a - Use of SUVR to Polish Residual NO_x and NH_3 Gases in a Wet Electrostatic Precipator for Sulfate and Nitrate Salts and Ash
102
UV Controller
High Voltage Electrode
36a
36a
Aerosol Particle Trajectories
Circulation of Wash Solution near Saturation With Calcium or Ammonium Salts
3.
4
2
1
101
Injection of Ammonia Based Reagent
18
19

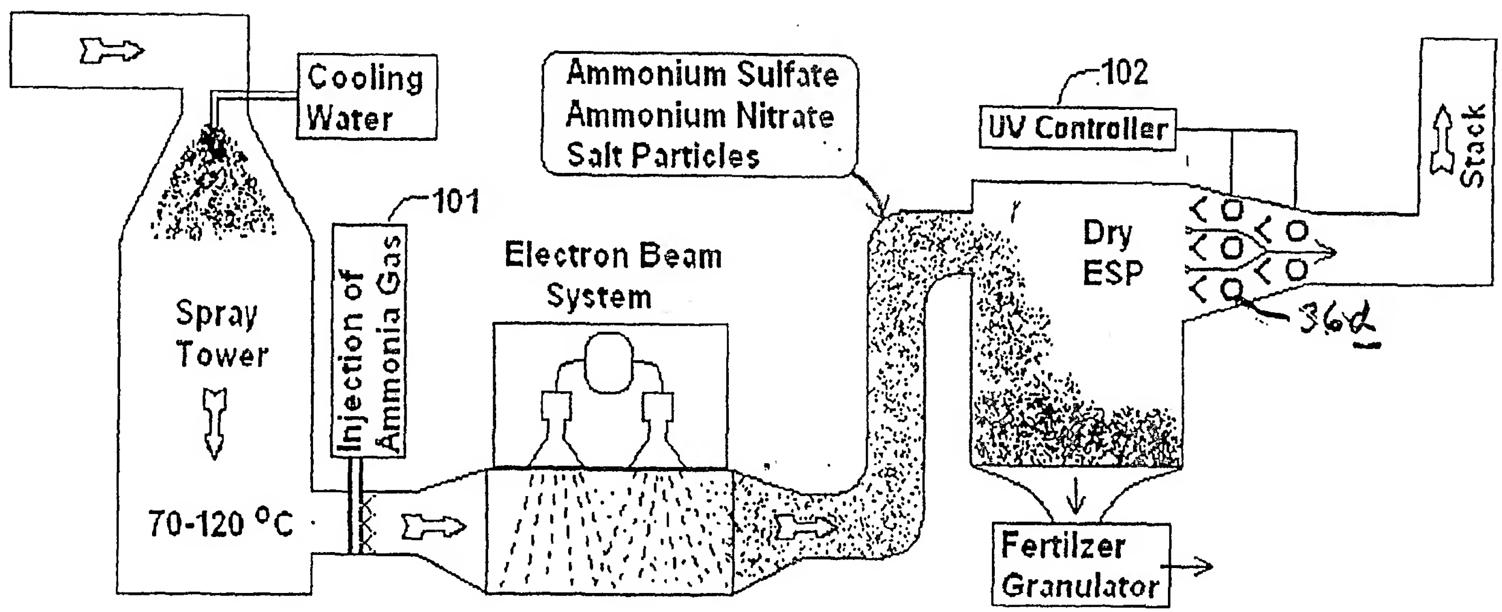


Figure 11b - Use of SUVR to Polish Residual SO_3, NO_X and NH_3 Gases from an Upstream Electron Beam System to Boost Efficiency to over 99%

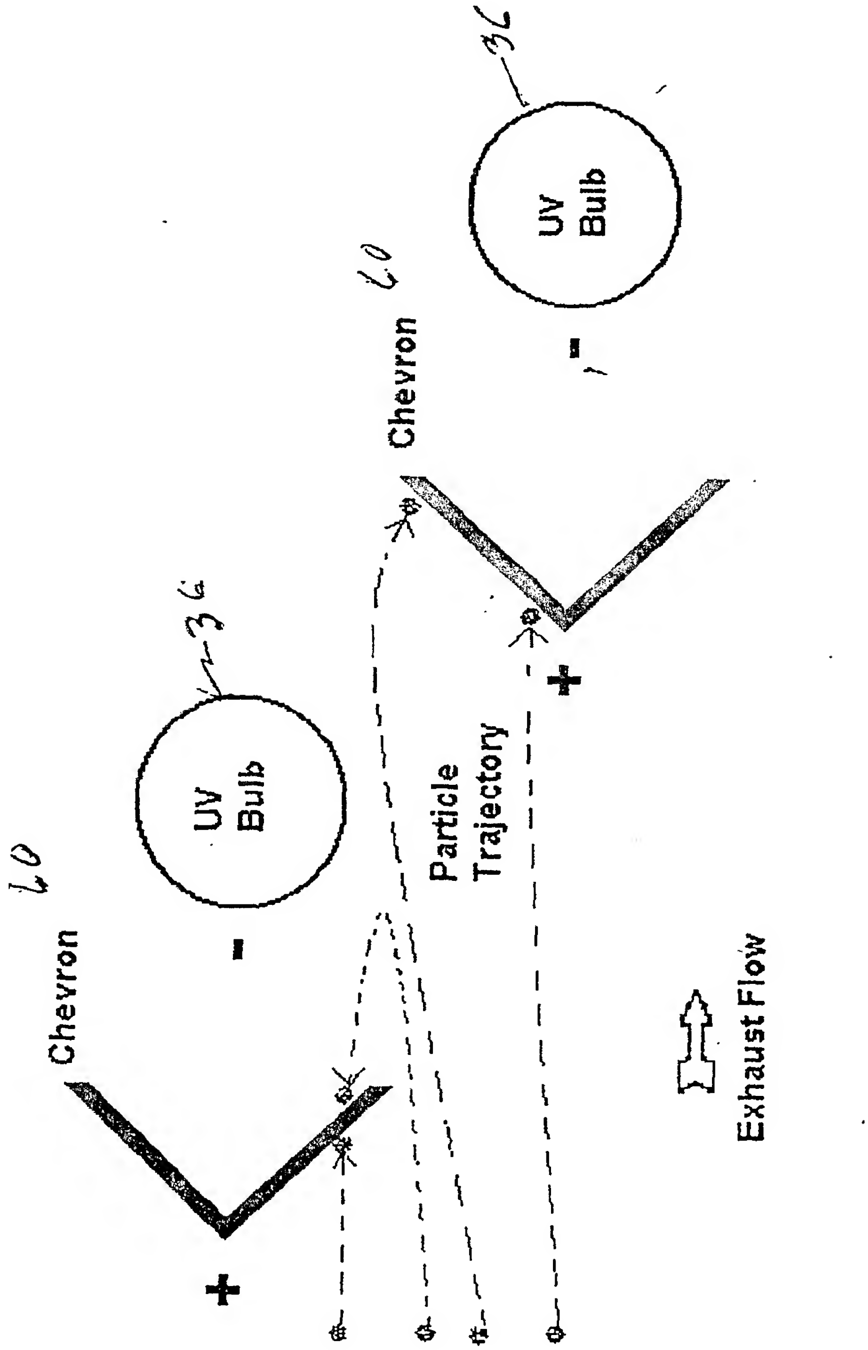


Figure 12 - Electrostatic Field Protection of Ultraviolet Bulbs in Dirty Exhaust Gases

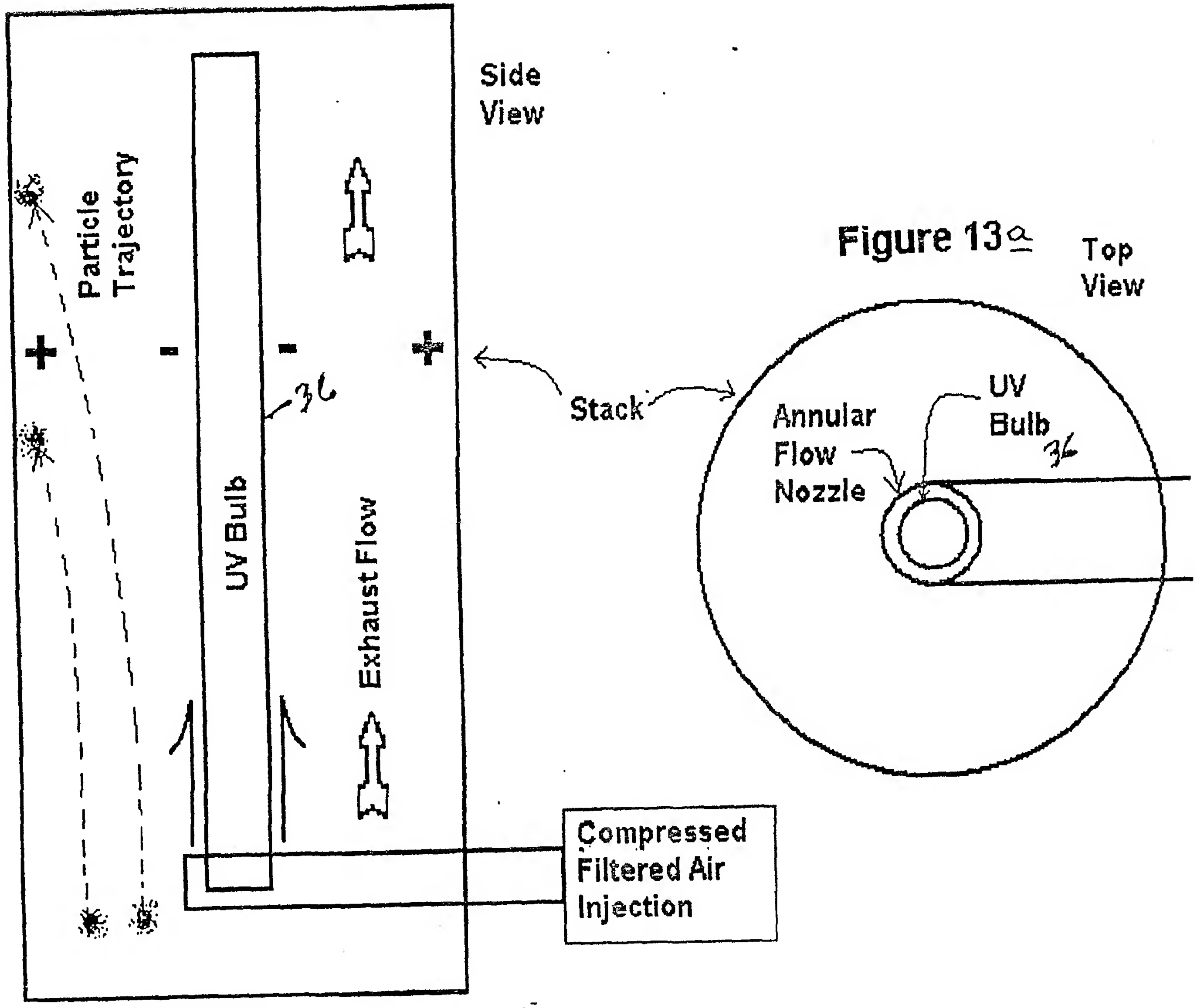


Figure 13 - Electrostatic Field + Boundary Layer of Clean Gas Protection of Ultraviolet Bulb in Very Dirty Exhaust Gases

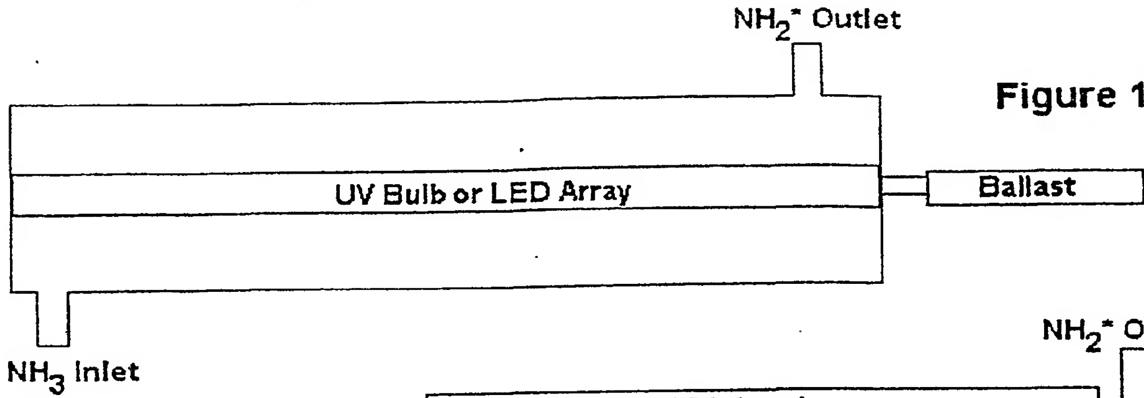


Figure 14a

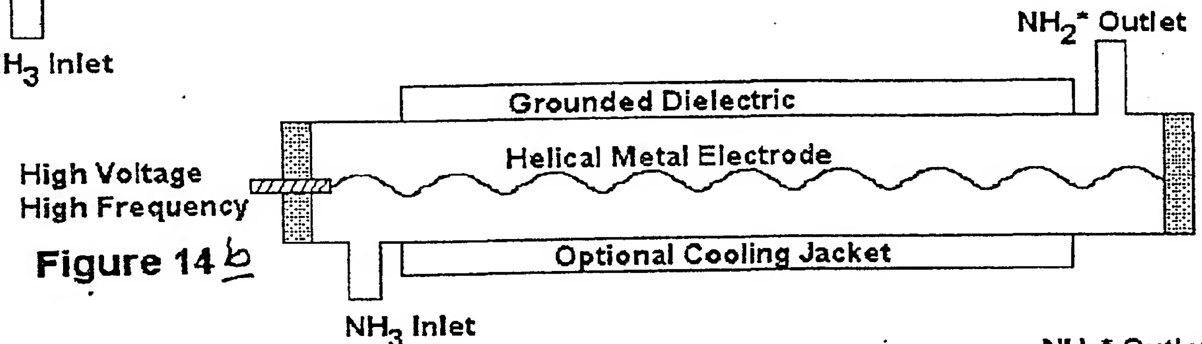


Figure 14b

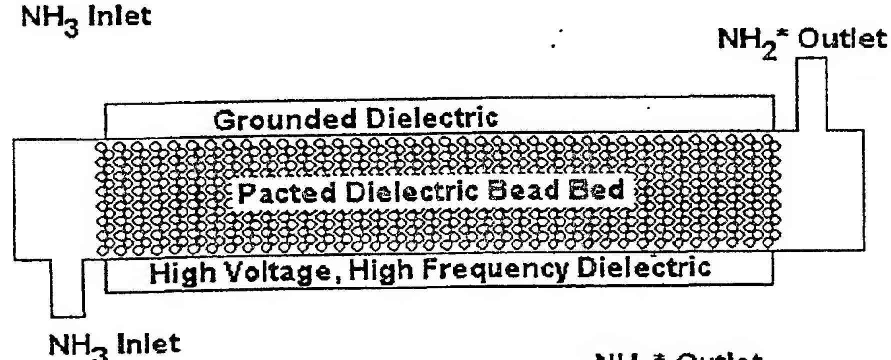


Figure 14c

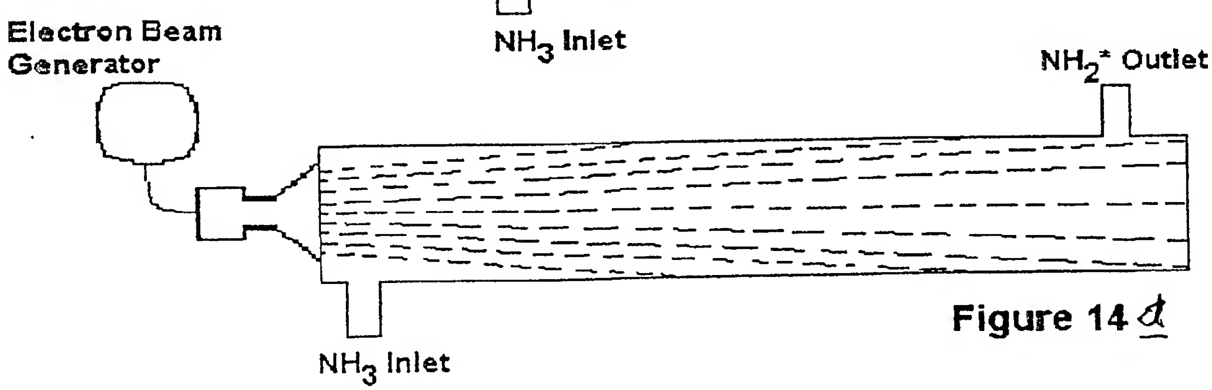


Figure 14d

Figure 14 - Amidogen Radical (NH_2*) Generators

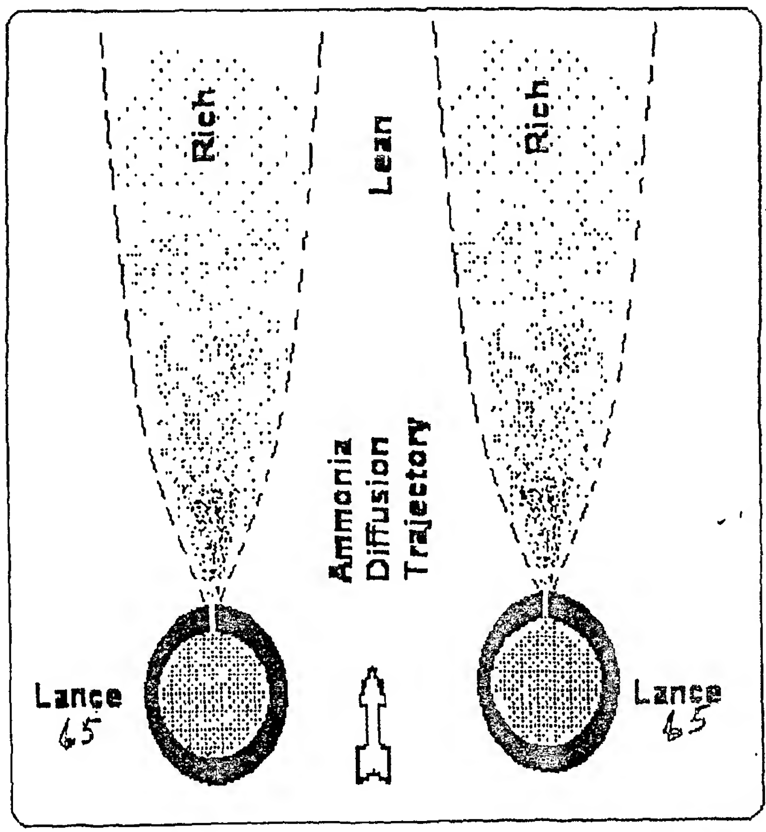


Figure 15a

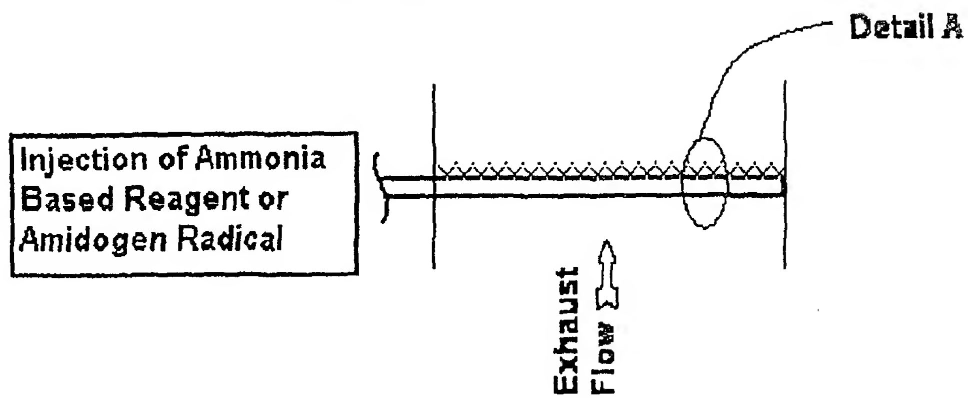


Figure 15 - Demonstration of ammonia gas mixing with lance or wall nozzle injection

Figure 16a

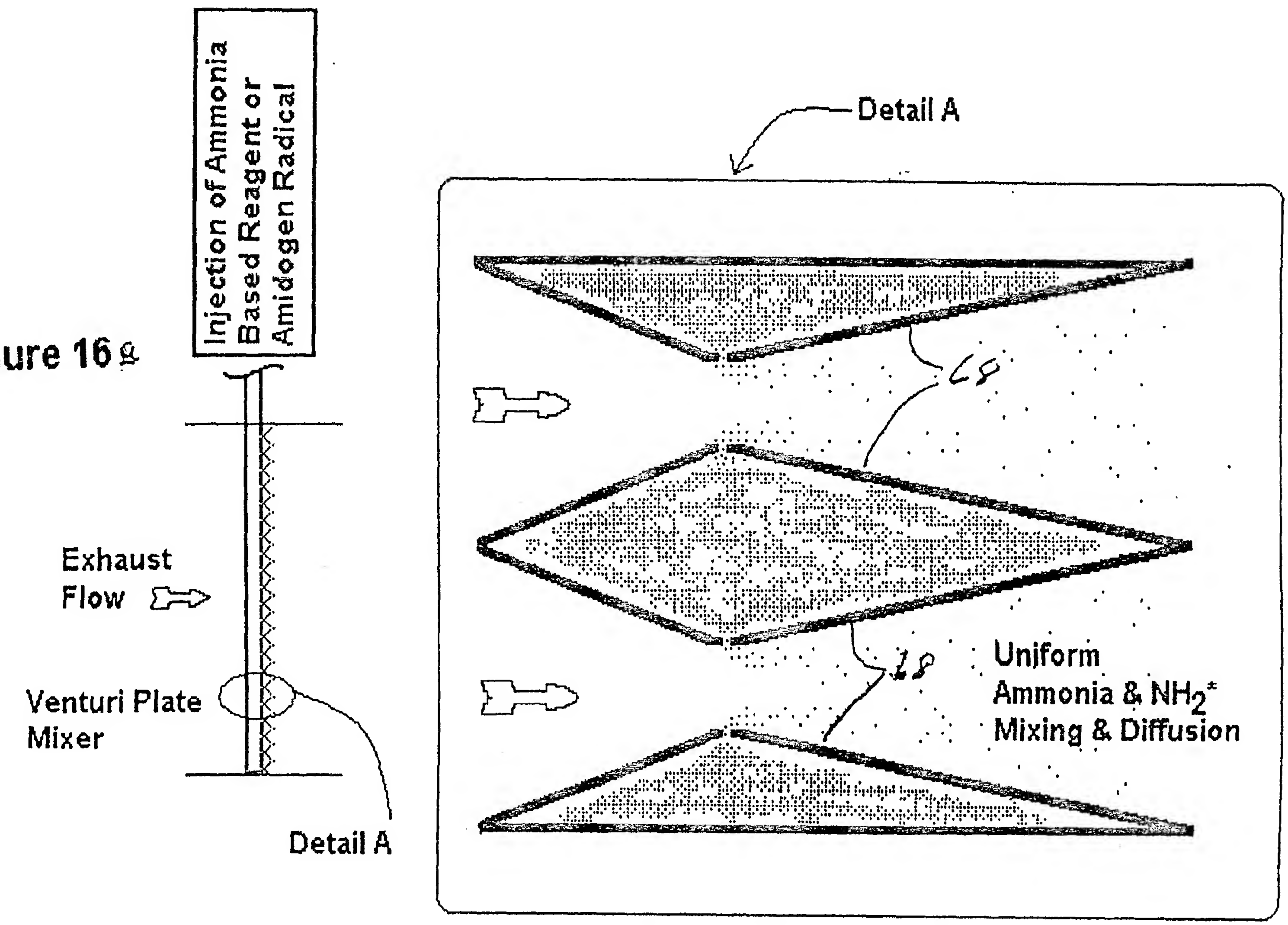


Figure 16 - Demonstration of ammonia gas mixing with a Venturi Plate

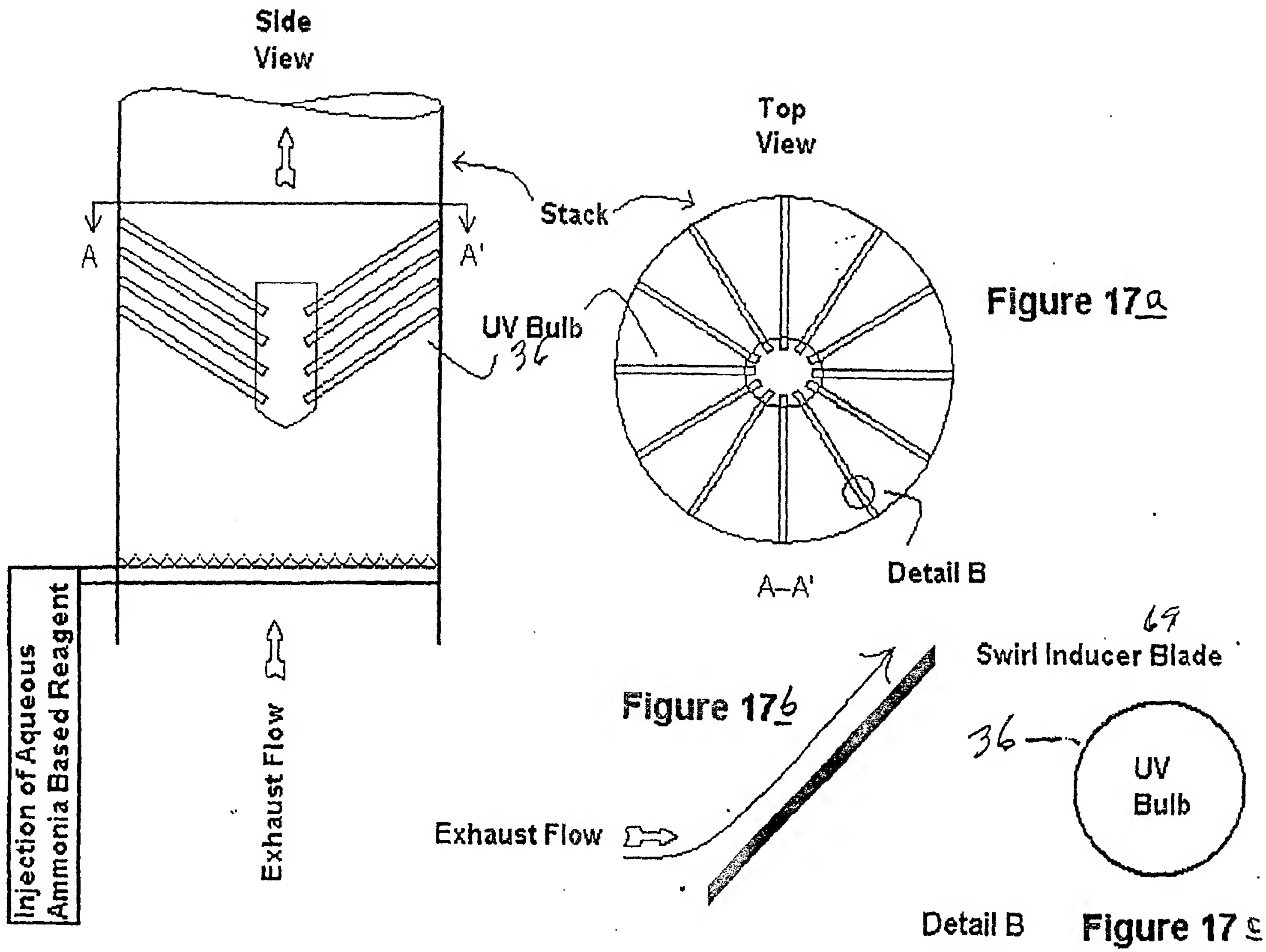


Figure 17 - Installation of the SUVR process on a hot exhaust stack using the vaporization of water to cool the exhaust gases and the thermal decomposition of urea to supply the ammonia

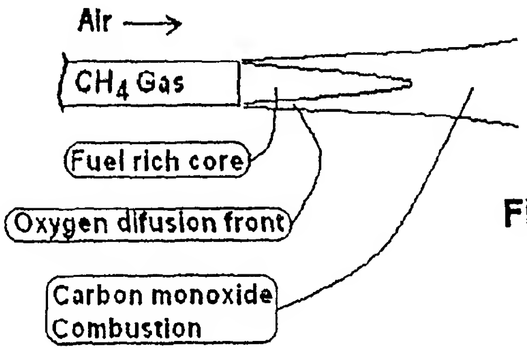
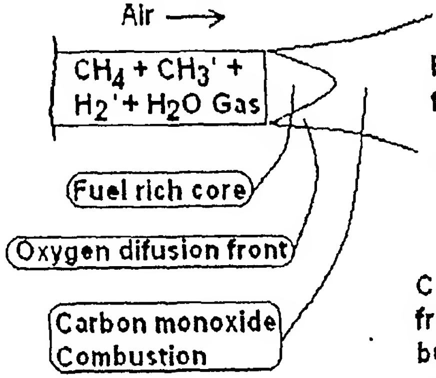


Figure 18a



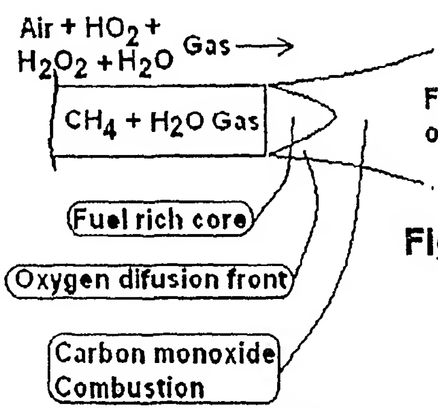
Flame ignited with free fuel based radicals

Figure 18b

Care must be taken to generate free radicals close enough to burner tip to prevent significant recombination before flame front

Fuel based free radicals generated with the addition of 1-2% air or 1-4% water vapor added to fuel then exposed to ultraviolet light, dielectric barrier discharge, electron beam, or laser discharge.

Liquid Fuel requires longer residence time and higher water vapor content to promote gasification of liquid without coking. Reformer generated hydrogen gas can also be used to dilute liquid fraction.



Flame ignited with free oxygen based radicals

Figure 18c

Oxygen based free radicals generated with the addition of 1-3% water vapor added to air then exposed to ultraviolet light, dielectric barrier discharge, electron beam, or laser discharge.

Figure 18 - Use of SUVR at burner to reduce VOC emissions. Increase Flame speed, and reduce NOx emissions

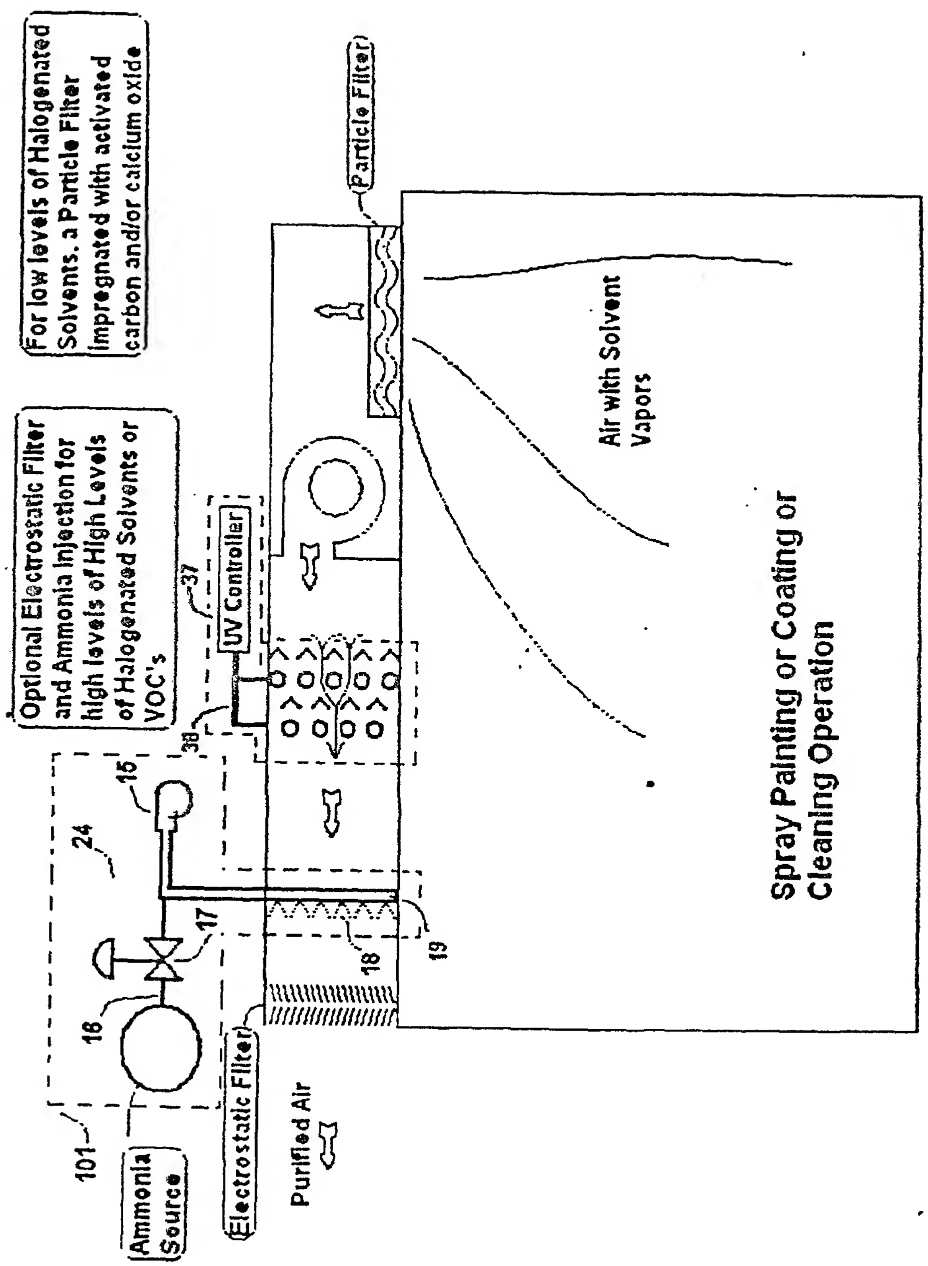


Figure 19 - Organic Compound Destruction Using SUVR with Optional Halogen Acid Removal

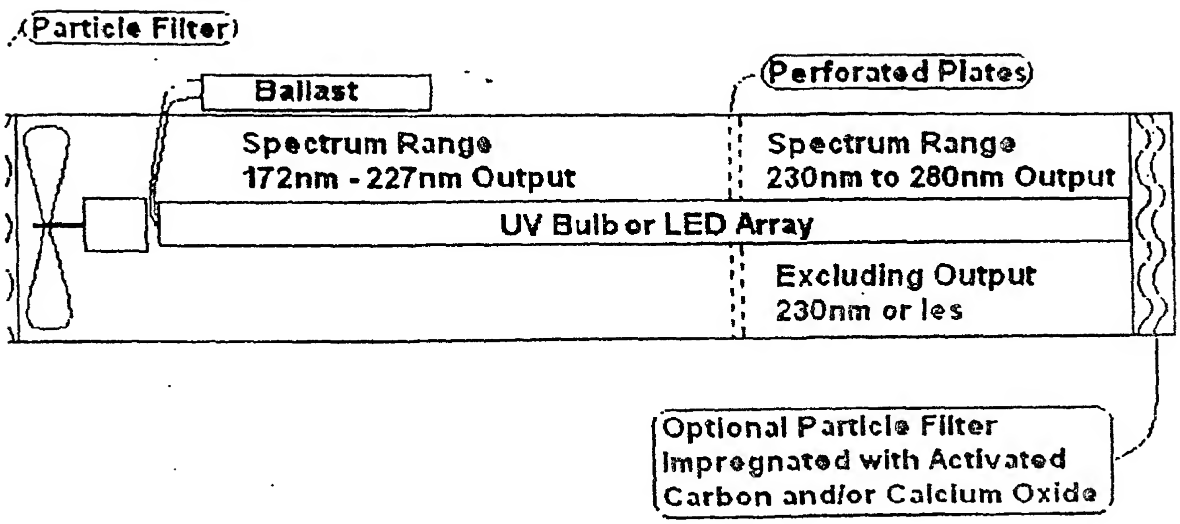


Figure 20 - Portable SUVR unit for Organic Compound Destruction